Concow Pyrodiversity Project
Hydrology and Soils Input

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Soil and Watershed Actions

There are approximately 7.4 miles of forest roads that fall within the Concow Pyrodiversity project area, these roads have the potential to impose local changes to hillslope processes, channel function, and soil properties of the watersheds they pass through. Local conditions and past disturbance have led to the degradation of many road sections in the project area, creating a need to implement a suite of road improvement actions to reduce road - related erosion, sedimentation, and hydrologic impacts.

Roads in the project area may be modified by adding drainage structures such as critical dips, rolling dips, dips with leadoff ditches, and ditch relief culverts, and by out-sloping certain segments of road. Other road improvement actions that may be implemented as part of the project include rocking inside ditches and segments of road. These actions will have the effect of reducing road surface erosion and will help create road infrastructure that is more resilient to future disturbance.

Road – stream crossings have the potential to affect watershed function by altering natural drainage pathways and restricting fluvial processes. Crossing upgrade improvements will be implemented at two stream crossings on the Dixie Road. These actions include clearing woody debris from the channel, armoring road fillslopes, replacing undersized culverts, road decommissioning, and berm removal. These actions were already cleared in a separate decision on this county road including the action outside of the road right away.

Table 1: Concow Pyrodiversity Project road improvement actions to improve water quality

Road ID	Road Improvement Worklist
Dixie Rd	• Clear woody debris upstream of the stream crossing. • Excavate fill and replace undersized culvert with a 72 in. diameter culvert. • Install riprap on the outboard fill slope. • Install a single post thrashrack 72 in. above the inlet. • Install rolling dips. • Decommission the skid road above and to the right of this crossing: rip the road surface for 500 ft. and install 5 cross-road drains. • Remove the left berm for 120 ft. and use the material to rebuild stream crossing approaches and shape the road to drain properly.
Dixie Rd	• Excavate fill and install a 42 in. diameter culvert. • Install riprap as energy dissipation above and below the culvert.

	• Construct a wing-wall on the right flank of the in-board edge of fill slope. • Install a single-post thrashrack 42 in. above the CMP inlet. • Install a critical dip to the right of the crossing. • Clean the ditch for 140 ft. to the right. • Define a 5 ft. wide channel bottom and lay the banks back to natural grade. • Install 2 rolling dips to the left road, connected to the ditch. • Outslope the trough of the dips.
Dixie Rd	• Excavate fill and large wood along the outboard fill slope to remove unstable material. • Store clean spoils locally for use reconstructing the road at Excavation #1. • Excavate fill along the outboard road edge to remove wood crib logs and debris • Reconstruct road with a 35 degree outboard fillslope angle. • Install riprap to support the outboard fillslope of the road. • Regrade existing rolling dip to enhance functionality and drivability. • Replace the water bar with a rolling dip, connected to the cutbank. • Install rolling dips to the left road. • Outslope the trough of the dip at 12% grade for 100 ft. • Endhaul spoils.

Other treatments not discussed in Table 1 that would be done are general road maintenance which includes cleaning inside ditches, cleaning ditch relief culverts, and blading road surfaces. Other issues found on these roads were general erosion due to the lack of maintaining road drainage features like dips and leadoff ditches. These issues where found on 23N19, 23N06, 23N06C, 23N63Y, and 23N63YB but they are not of water quality concern since they don't connect to streams.

Restrictions and Design Features

Below are some of the most crucial Best Management Practices (BMPs) for soils and watershed. More specific design features are located in project appendix that contains all the resources design features/mitigations.

- All skid trails and temporary roads will have waterbars as erosion control features.
- Adhere to FS-990a National Best Management Practices for Water Quality Management on National Forest System Lands, Volume 1: National Core BMP Technical Guide (April 2012), in particular:
  - Mechanical Vegetation Management Activities: Veg 1-4 (especially Veg -3, Aquatic Management Zones), 6, and 8
  - Road Management Activities: Road-4 and Road-7
  - Wildland Fire Management Activities: Fire-1 and Fire-2
- Adhere to R5 FSH 2509.22 Soil and Water Conservation Handbook, Chapter 10 Water Quality Management Handbook, Amendment # 2509.22-2011-1 (Dec 05, 2011). In particular, BMPs 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.9, 1.10, 1.11, 1.12, 1.13, 1.14, 1.15, 1.16, 1.17, 1.19, 1.20, 1.21, 2.2, 2.3, 2.4, 2.5, 2.6, 2.8, 2.11, 5.1, 5.2, 5.4, and 5.6.
  - See Table 2 for the RCA Heavy Equipment Exclusion Zone

- Limiting Operating Period (LOP) (BMP 1-5, BMP 1-13) for soil moisture.
- Conduct ground based harvest operations when soil is dry; that is, in the spring when soil moisture in the upper 8 inches is not sufficient to allow a soil sample to be squeezed and hold its shape, or will crumble when the hand is tapped. In the summer and early fall after storm event(s) when soil moisture between 2-8 inches in depth is not sufficient to allow a soil sample to be squeezed and hold its shape, or will crumble when the hand is tapped. Work on streams should occur during low flow (late summer)
- If effective soil cover is below the desired level of soil cover along streams then leave slash material to increase soil cover. When cutting trees lop and scatter broken tops and limbs within 1 tree length of any stream.
- Fuel outside of riparian areas. 300 feet on perennial and 150 feet on seasonal flowing streams.
- BMP 2.11 (Equipment Refueling and Servicing) will prevent fuels, lubricants, cleaners, and other harmful materials from discharging into nearby surface waters or infiltrating through soils to contaminate groundwater resources.

Regulatory Framework

Protection of both water quality and quantity is an important part of the Forest Service's mission (USDA Forest Service, 2007). Management activities on national forest lands must be planned and implemented to protect the hydrologic functions of forest watersheds including the volume, timing, and quality of streamflow. The Clean Water Act of 1948 (as amended in 1972 and 1987) establishes federal policy to control point and non-point source pollution and assigns to the States primary responsibility over control of water pollution. The Forest Service is required to protect and enhance existing and potential beneficial uses during water quality planning (California Regional Water Quality Control Board [CRWQCB], 1998). Compliance with the Clean Water Act by national forests in California is achieved under state law. Beneficial uses are defined under California State law in order to protect against degradation of water resources and to meet state water quality objectives. The 1988 Plumas National Forest Land and Resource Management Plan states: "maintain or, where necessary, improve water quality using Best Management Practices (BMPs)". BMPs are procedures, techniques, and mitigation measures that are incorporated in all Plumas National Forest actions to protect water resources and prevent or diminish adverse effects to water quality. Subsequent Forest Plan standards and guides state: "implement BMPs to meet water quality objectives and improve the quality of surface water on the Forest."

Direct and Indirect Effects of Vegetation Management Activities

The proposed project would reduce surface and ladder fuels throughout the project area using a variety of treatments such as mastication, yarding of fuels, grazing, hand-cut pile, pile burning and prescribed fire. The project will be implemented in three phases with Phase 1 consisting of a total of 1,035 acres, Phase 2 consisting of 781 acres and Phase 3 consisting of 76 acres.

Riparian Conservation Areas (RCA) is a land management designation which has more protective management requirements to protect the sensitive resources in and around aquatic features. RCAs are composed of wetlands, wet meadows, lakes, fens, springs, and seasonal and perennial streams and the land adjacent to those features. Within the project area there is a need to implement vegetation treatments such as prescribed fire, mechanical and hand thinning, and grazing to make the RCAs more fire resilient. The utilization of BMPs, design features and proper buffers for RCAs is crucial to treating within RCAs to preserve their hydrological function and their associated beneficial uses

Table 2 indicates the allowed treatments within RCAs to reduce fuels and make them more fire resilient. Mechanical treatments may occur in RCAs and will be limited to the buffers described in Table 2.

Table 2. RCA Heavy Equipment Exclusion Zone Widths and Slope Restrictions

Stream Type	Yarding and Machine Piling of Slash		Mastication		Underburn[1]	Hand Cut[2]	Minimum Distance to Burn Piles
	Slope <35%	Slope >35%	Slope <35%	Slope >35%			
Perennial streams	100 feet	Excluded	50 feet	Excluded	150 feet	No buffer	25 feet
Intermittent streams	100 feet	Excluded	50 feet	Excluded	150 feet	No buffer	25 feet
Ephemeral streams	50 feet	Excluded	50 feet	Excluded	150 feet	No buffer	25 feet
Special Aquatic Features (Reservoirs, wetlands, fens, and springs)	50 feet	Excluded	50 feet	Excluded	150 feet	Perimeter	25 feet
Riparian Features: dry meadows, seasonal wetlands	25 feet	Excluded	25 feet	Excluded	150 feet	Perimeter	25 feet

1. Prescribed burning would be allowed within RCAs, but there would be no ignitions in riparian vegetation. Fire may back through this zone.

2.May hand cut within RCA feature but don't cut riparian vegetation. Don't cut vegetation that provides stream bank stabilization. Adhere to the minimum distance for burn piles. No hand cutting within special aquatic features and riparian features unless marked by hydrologist and/or biologist.

Canopy cover is an important component for water temperature of streams and the micro climate of meadows. The designation of Streamside Management Zones (SMZs) will establish a zone of closely managed activity based on local conditions, project limitations and forest guidelines (USDA Forest Service, 1988). The establishment of SMZs will help maintain streamside shade; protect aquatic and terrestrial riparian habitats; protect channel and streambanks; and promote floodplain stability in the areas affected by project activities.

Prescribed fire and other proposed vegetation manipulation activities have the potential to increase surface runoff and erosion in the project area. As discussed in the soils section, decreases in effective soil cover post-implementation are not anticipated to be significant, but if a

unit were not to meet the project standard of 50 percent for effective soil cover than the design feature to increase effective soil cover would be implemented. The designation of SMZs and exclusion zones will ensure an effective filter and absorptive zone for sediment and surface runoff remains intact, which can help prevent degradation of water quality in and downstream of the project area. Other BMPs that will help minimize the potential for surface runoff from reaching any stream including: 1.14 special erosion-prevention measures on disturbed land, 1.17 erosion control on skid trails, 1.19 erosion-control structure maintenance, and 6.3 protection of water quality from prescribed burning effects.

Much of the project area lies within the Flea Valley Creek drainage, a steep and deeply dissected NE-SW trending valley drained by numerous intermittent and ephemeral stream channels. Both shallow and deep-seated landslide features have been observed within this drainage from aerial imagery and Digital Elevation Models (DEMs). Changes in vegetative cover as a result of the proposed activities have the potential to affect soil root support and hillslope moisture, which can affect landslide hazards in the project area (Istanbulluoglu and Bras, 2005). Although past and dormant landslides are unlikely to be mobilized by human activities, their steep headwalls and margins are often unstable. To reduce the risk of landslide initiation as a result of project activities, unstable areas should be assessed by a qualified specialist before and after treatment.

Mastication will remove existing ladder fuels and re-arrange them as surface fuels. This treatment is unlikely to produce additional surface runoff because it creates greater surface soil cover and a rougher surface texture, which helps reduce the formation and velocity of surface runoff. The masticator equipment will be limited by the equipment exclusion zone along RCAs as identified in Table 2. The defined equipment exclusion zones will prevent a significant change in canopy and ground cover within the RCA, therefore mastication treatments are unlikely to change water quality and its beneficial uses in or downstream of the project area.

Hand cut and pile burn treatments within RCAs are intended to reduce fuels loads before underburning and will help limit fire severity in the RCAs. Hand cutting within the entire RCA, regardless of the type of stream will be allowed. Hand cutting of conifers up to 10 inches in DBH would be allowed in the entire project area, including within the RCA, and the piles would be place at least 25 feet away from any stream bank or other aquatic feature. Burn piles may be ignited independent of an underburn but should be placed at least 25 ft. from the edge of stream banks and springs before ignition. Hand treatments within RCAs will not significantly change effective soil cover or percent canopy cover, therefore it is unlikely this action will adversely affect water quality or its beneficial uses in the project area.

Goat grazing will be allowed as an alternative treatment to prescribed fire and/or hand cut and pile within RCAs and will be allowed within the entire RCA area. The goats would primarily target live understory that they can reach and not eat the soil cover unless it's some type of grass. A significant reduction in soil cover is not expected from grazing treatments and it is unlikely these treatments would induce erosion that would affect water quality.

Prescribed fire will be implemented across most of the project area, and will serve as the primary treatment method to reduce hazardous fuel loads in the Flea Valley Creek and Camp Creek

watersheds. Underburning will take place within the RCAs and will be allowed to back into these features under ideal conditions. To protect water quality, prescribed fire treatments will be ignited no closer than 150 ft. away from any stream, spring, and meadow. The BMP Evaluation Program from 2010-2012 found that prescribed fire BMPs were rated at 100 percent for implementation and 97 percent for effectiveness (USDA Forest Service, 2013). The high success rate of implementation and effectiveness of BMPs when conducting underburns means that the Forest Service met or exceeded project identified effective soil cover, and little or no hydrophobic soils and erosion was observed to have been created by these treatments.

Miles of Road Improved and Maintained

Road surveys were conducted in 2021 and assessed from a watershed perspective. Roads identified as a high priority were identified based on the number and significance of the hydrologic issues. Moderate prioritization was given to roads where minor hydrologic issues were identified or where drainage upgrades could improve the longevity of the road. Low prioritization was given to roads that had no hydrologic issues but would benefit from general road maintenance. Approximately 0.95 miles of road were identified as high priority and 2.3 miles as moderate priority.

Table 3: Road Improvement Priority List

Road ID	Length	Priority
23N19	1.8	Moderate
Dixie Rd.	0.95	High
23N63Y	1.8	Low
23N63YB	0.3	Low
23N06C	1.5	Moderate

Cumulative Watershed Effects

The Cumulative Watershed Effects (CWE) analysis for the Concow Pyrodiversity Project is based on a combination of field surveys, GIS mapping, land use history, and past management actions following guidance from the Forest Service Handbook FSH 2509.22-Soil and Water Conservation, Region 5 Amendment (USDA Forest Service, 1988b)

The watersheds within the project area burned at moderate-high severity in the BTU Lightning Complex Fire of 2008 and again in the 2018 Camp Fire. Large scale and recent disturbances such as high severity wildfire serve as an indicator of increased risk for cumulative effects within project watersheds. Watersheds and stream channels have a natural capacity to absorb various levels of land disturbance without major adjustment to their function and condition. However, there is point where additive or synergistic effects of land use activities would cause a watershed to become highly susceptible to cumulative effects.

The physical attributes of project watersheds and their relationships to climate, hillslope and stream channel geomorphology, hydrology, soils, geology, and physically and biologically sensitive land units has been used to develop a general understanding of the watershed systems

affected by the proposed activities. Anticipated watershed responses to the changes in land use have been critical to the development of project design features, BMPs, SMZs, and equipment exclusion zones.

Close inspection of the type of treatments and timing of implementation indicate that there is a low probability that water quality and its beneficial uses would be cumulatively impacted in a detrimental way. The overall effectiveness of 93.8 percent of timber associated BMPs from 2010-2012 and 98 percent effectiveness of prescribed fire associated BMPS (USDA Forest Service, 2011b) demonstrate that any increase in hillslope sediment production rates as a result of the proposed actions is unlikely to reach stream channels in the project area. Additionally, forensic monitoring will ensure that if any kind of significant discharge of sediment is observed at any time in any Class I or Class II watercourse that corrective actions would occur to fix the failed management measures.

Monitoring Recommendations

Forensic monitoring is a condition through the Central Valley Regional Water Quality Control Board (CVRWQCB) in which the Forest Service applies to be enrolled under the Waste Discharge Requirements General Oder for Discharges Related to Timberland Management Activities. Forensic monitoring is defined as a visual field detection technique used in the winter period within the project area to determine the condition of installed management measures and to identify threatened or actual significant sediment discharges (CRWQCB, 2017). “The goal of winter forensic monitoring is to locate potential or actual sources of sediment in a timely manner so that rapid corrective action may be taken where feasible and appropriate” (CRWQCB 2017).

Given the occurrence of recent high-severity wildfire, steep slopes, and erosive geology within the project area it is recommended that forensic monitoring occurs at least two times in the winter post-treatment when storm events of a particular size occur.

Soil Analysis

The soils analysis looked at the soils hydrologic function, ability to support plant growth, and filtering buffer function. The qualitative analysis will disclose the existing condition and compare it to the proposed activities.

Soil Assessment and Assumptions

Soil surveys were conducted in June 2021 across five survey units in or near the proposed treatment areas. Soil survey units were selected based on soil types, fire history, initial erosion hazard rating, and past management activities. The data collected were sample points in proposed treatment units along systematic randomized transects designed to sample the geographic and topographic extent and variation of the project area. Transects were randomly located using topographic maps and modified in the field to ensure the collection of necessary information. Each survey unit had a minimum of two transects where data was collected systematically to obtain a total of 60 sample points for each unit. Information on slope, soil

compaction, soil cover, soil disturbance, soil displacement, and surface erosion were recorded at each sample point. Soil texture and structure were recorded every 10th point. The soil indicators below will be rated as good, fair or poor in relation to meeting desired conditions.

Support for Plant Growth and Soil Hydrologic Functions

Soil Stability

An adequate level of soil cover is maintained to prevent accelerated erosion, and erosion prevention measures are effectively implemented following soil disturbing activities.

Percent Effective Soil Cover

- Duff and litter greater than ½ inch in depth, surface gravels greater than ¾ inch in diameter, woody debris greater than ¼ inch in diameter, and living vegetation count as effective soil cover.
- The Plumas National Forest Land and Resource Management Plan (LRMP) states soils with low, moderate, high and very high Erosion Hazard Ratings (EHRs) require a minimum of 40 percent, 50 percent, 60 percent and 70 percent effective soil cover, respectively. Units with low EHRs require a minimum of 40 percent effective soil cover under the LRMP, but for this analysis the minimum will be set at 50 percent due to the Region Five National FSM Supplement for Soil Management which indicates soil cover 50 percent or greater is the desired condition.
- Soils surveyed had their EHRs recalculated and the ones that weren't have EHRs set for moderate at 50 percent effective soil cover.
- Good rating is when soil cover is found to be at or greater than 50 percent. Signs of erosion are not visible or very limited in degree and extent.
- Fair rating is when soil cover falls below 50 percent and is within 5-15 percent. There are signs of erosion such as pedestals, sheet, rill, and/or gully erosion visible.
- Poor rating is when soil covers fall well below desired condition of 50 percent. Signs of erosion such as pedestals, sheet, rill, and/or gully erosion are common.

Support for Plant Growth

Surface Organic Matter

The amount of organic material on top of the mineral soil is maintained at levels to sustain soil microorganisms and provide for nutrient cycling.

Percent Fine Organic Matter

- Duff and litter greater than ½ inch in depth and woody debris between ¼ to 3 inches in diameter will count as fine organic matter on top of mineral soil.

- Good condition is when fine organic matter on top of mineral soil is 50 percent or greater.
- Fair condition is when fine organic matter falls below desired condition but is within 5-15 percent.
- Poor condition is when fine organic matter falls below 15 percent of the desired condition.

Soil Organic Matter (SOM)

The amount of organic matter within the mineral soil, indicated by the color and thickness of the upper soil horizon, is within the normal range of characteristics for the site, and is distributed normally across the area.

Percent Displacement

- Soil displacement is evaluated and graded pass or fail – yes or no at every sample point. Displacement is defined as the removal or loss of either 4 inches of topsoil or more than half of the humus enriched topsoil (A horizon) from a contiguous area greater than 100 square feet.
- Good condition is when localized areas of displacement may have occurred, but it will not affect the productivity for the desired plant species. If displacement is less than 5 percent, then it is in good condition.
- Fair condition is when over minor portions of the area, the upper soil layer has been displaced or removed to a depth and area large enough to affect productivity for desired plant species. If displacement ranges from 5-15 percent, it is in fair condition.
- Poor condition is when major portions of the area have had the upper soil layer displaced or removed to a depth and area large enough to affect productivity for the desired plant species. Poor condition is when displacement is over 15 percent and major portions of the area do not meet the desired condition.

Soil Strength

The soil strength level is conducive to favorable rooting environment for the desired plant species. Some level of increase in strength compared to a natural undisturbed condition may not be undesirable.

Percent Compaction

- Soil compaction is determined at a depth of 4 to 8 inches at every sample point by inserting a spade or shovel into the soil. If the spade is inserted without difficulty the soil is non-compacted. If the soil is resistant to insertion of a spade or shovel, a shovel-full of soil is removed and soil structure examined for indications of compaction (platy or massive soil structure).

- Good condition is when over most of the area soil strength level is conducive to a favorable rooting environment for desired plant species. If soil compaction is less than 5 percent, it is in good condition.
- Fair condition is when over minor portions of the area, soil strength has increased in degree and depth such that it limits the growth of desired plant species. If soil compaction ranges from 5-15 percent, it is in fair condition.
- Poor condition is when over major portions of the area soil strength has increased in degree and depth such that it limits the growth of desired plant species. If soil compaction is over 15 percent throughout the area, if is in poor condition.

Soil Moisture Regime

The inherent soil moisture regime is maintained, especially in wet meadows and fens. If needed, propose projects that will restore the soil moisture regime. During land management project analysis, evaluate whether the proposed activities will result in changes to the soil moisture regime, particularly in wet meadows and fens.

Acres of Wet Meadow and Fens Treated

- During hydrological mapping of project, riparian features such as wet meadows and fens were recorded.
- If needed, propose projects that will restore the soil moisture regime.

Soil Hydrologic Function

The soil hydrologic function is the inherent capability of the soil to absorb, store and transmit water within the soil profile. The capability is dependent upon an adequate level of cover to reduce rainfall impact and runoff energy, stable soil structure, and sufficient macro-porosity to permit water infiltration and movement through the soil.

Soil Structure and Macro-porosity

Soil structure and macro-porosity (defined here as pores 1mm or larger) that is similar to the undisturbed natural condition for the soil type and provides sufficient infiltration and permeability to accommodate precipitation inputs for the given climate. Soil surveys recorded soil texture at the beginning and end of survey transects, whenever soil was textured, and whenever soil compaction was suspected. Soil structure and macro-porosity condition ratings are derived using soil structure and percent erosion and compaction.

Percent Soil Erosion

- Soil surveys at every point looked within a 37 foot radius for signs of rilling and gullying at least 20 feet in length.

- Good condition is when visually soil structure and macro-porosity are relatively unchanged from natural condition for nearly all the area. Signs of erosion or overland flow are absent or very limited in degree and extent. Infiltration and permeability capacity of the soil is sufficient for the local climate. If the average soil compaction and erosion is less than 5 percent, then it is in good condition.
- Fair condition is when over minor portions of the area soil structure and macro-porosity are changed, platy structure and/or increased density are evident, or overland flow and signs of erosion are visible. Infiltration and permeability capacity is insufficient in localized portions of the area. If the average soil compaction and erosion is between 5 -10 percent, then it is in fair condition.
- Poor condition is when major portions of the area have reduced infiltration and permeability capacity indicated by soil structure and macro-porosity changes, or platy structure and/or increased density, or signs of overland flow and erosion. If the average soil compaction and erosion is greater than 15 percent, then it is in poor condition.

Qualitative Assessment of the Soils Filtering-Buffering Function

Soil filtering and buffering capacity is the soils ability to protect water quality by immobilizing, degrading, or detoxifying chemical compounds or excess nutrients. This qualitative assessment will look at potential changes to soil filtering and buffering capacity between existing condition and proposed action.

Existing Condition

Soil surveys were conducted in June 2021 on approximately 24 percent of the project area, which is considered a representative sample of the existing conditions throughout the proposed treatment area. Soil survey units were selected based on soil types, fire history, initial erosion hazard rating, and past management activities. The results of soils surveys are summarized in Tables 4 and 4b.

Table 4: Summary of survey results from the Concow Pyrodiversity Project analysis area

Soil Survey ID	Soil Texture	Average Slope	E.H.R	Effective Soil Cover	Soil Stability Rating	Fine Organic Material	Surface Organic Matter Rating
CP01	Sandy Loam	27%	Low	78%	Good	63%	Good
CP02	Silt Loam	32%	Low	97%	Good	57%	Good
CP03	Silty Clay Loam	46%	Moderate	80%	Good	25%	Poor
CP04	Silty Clay Loam	42%	Moderate	77%	Good	37%	Fair

CP05	Silty Clay Loam	22%	Low	88%	Good	37%	Fair

Table 4b: Summary of survey results from the Concow Pyrodiversity Project analysis area

Soil Survey ID	Displacement	Soil Organic Matter Rating	Compaction	Soil Strength Rating	Erosion	Soil Structure and Macro-Porosity Rating
CP01	6%	Fair	9%	Fair	22%	Fair
CP02	3%	Good	12%	Fair	0%	Fair
CP03	0%	Good	38%	Poor	0%	Poor
CP04	13%	Fair	25%	Poor	0%	Poor
CP05	2%	Good	18%	Poor	0%	Fair

Table 5: Components of Effective Soil Cover

Soil Survey ID	Duff and Litter				Woody Debris			Live Vegetation Only	Rock >0.75	Effective Soil Cover
	0.5-1"	1-2"	>2"	Mixed	0.25-3"	3-16"	>16"			
CP01	23%	3%	1%	1%	13%	8%	1%	–	1%	78%
CP02	13%	4%	–	–	17%	7%	7%	7%	3%	97%
CP03	15%	–	–	–	–	3%	1%	–	29%	80%
CP04	5%	1%	–	–	16%	2%	1%	8%	13%	77%
CP05	7%	–	–	–	15%	1%	–	–	30%	88%

All surveyed units had higher than 50 percent effective soil cover, and thus a good soil stability rating. The average effective soil cover across all surveyed units is 85 percent, with a high of 97 percent and a low of 75 percent. The breakup of effective soil cover by duff, woody debris, living vegetation and rock cover is displayed in Table 5; the majority of effective soil cover across the project area is rock over ¾ in in diameter, followed by fine woody debris and ½ in to 1 in duff and litter layer. Based on survey results, it is assumed non surveyed regions will meet the project standard of 50 percent effective soil cover within the project area and therefore have good soil stability.

Units 01 and 02 meet the desired condition of 50 percent fine organic material, giving them a good surface organic matter rating. Units 04 and 05 received a fair surface organic matter rating as they both have 36 percent fine organic matter. Unit 03 received a poor surface organic matter

rating with 25 percent fine organic material. The surface organic matter ratings reflect the breakdown of effective soil cover components (Table 5); the majority of effective soil cover for units 01 and 02 are duff/litter and woody debris, whereas the effective soil cover for units 03 and 05 is mostly rock over ¾ in in diameter. Unit 04 has a larger proportion of fine woody debris than units 03 and 05, but not enough to qualify as good for surface organic matter. The results of the surveys indicate fine organic material is highly variable across the project area, with units rated fair or poor strongly correlated to areas burned at moderate to high severity during the 2018 Camp Fire. Based on the survey results and fire history it can be assumed that the portions of the project area unaffected or burned at low severity by the Camp Fire (units 01 and 02) meet the desired conditions of percent fine organic material, while units that burned at moderate to high severity do not (units 03, 04, and 05).

Soil displacement was below 5% in survey units 02, 03, and 05 resulting in a good soil organic matter rating for all three units. Survey units 01 and 04 have fair soil organic matter ratings due to the presence of soil displacement between 5 and 15 percent. Soil displacement observed in unit 01 is mainly associated with system roads, old roads, skid trails, and landings however; the granite derived soils found in this unit are naturally more erodible than other soil types in the project area. Within unit 01 erosional features such as rilling and gullying are commonly found adjacent to locations where previous ground disturbing activities have taken place. Unit 04 has 12% displacement due to localized anthropogenic excavation and associated sheet wash erosion. On closer examination, the high displacement percentage observed in the surveyed portion of unit 04 can be attributed to the transect location. A high displacement percentage does not appear representative of the entire unit.

The survey results indicate the majority of the treatment units will have a good soil organic matter rating and minimal displacement. In areas where previous ground disturbing activities have occurred on steep slopes or erosive soil textures (e.g., unit 01 and 04) displacement may be more prevalent with either a good or fair soil organic matter rating likely.

None of the surveyed units were under 5 percent soil compaction, and therefore none received a good rating for soil strength. The average soil compaction is 21 percent with a low of 8 percent in unit 02, and a high of 42 percent in unit 03. Units 01 and 02 received a fair soil strength rating as their percent compaction is within 5 and 15 percent. Units 03, 04 and 05 received a soil strength rating of poor as all are above 15 percent compaction. The compaction observed in units 01 and 02 is primarily associated with system roads and old skid trails. For the remaining units, high levels of compaction correspond to areas recently burned at high-moderate severity during the Camp Fire. Important physical characteristics in soil can be affected by extreme soil heating during wildfire include: texture, clay content, soil structure, bulk density, and porosity (Neary et.al, 2008). Based on survey results, it can be assumed that soil strength is either fair or poor throughout the project area, with compaction rates highest in areas affected by recent high severity wildfire.

The average erosion across surveyed units is 6 percent with generally low rates observed throughout the project area (Table 4b). Unit 01 is underlain by granitic parent material, which breaks down to form very coarse grained soils with little to no clay content; these soils are easily erodible, leading to a significantly higher erosion rate than other units in the project area (Table 4b). Though erosion is generally low in the project area, the high rate of compaction and variability of soil structure results in all of the units receiving a fair or poor rating for soil structure and macro-porosity.

In unit 01 soil structure remained largely unchanged from natural condition; however, the fair rating for soil structure and macro-porosity can be attributed to a high amount of naturally occurring erosion and ground disturbance related compaction. Compaction in unit 02 is relatively low and no significant erosion was found, but soil structure varied throughout the unit. Massive soil structure was occasionally observed in unit 02 and is likely a result from a combination of recent wildfires and/or ground disturbing activities such as timber harvesting. Overall, unit 02 received a fair rating for soil structure and macro-porosity. Unit 05 has a compaction-erosion average of 9 percent and a variety of soil structures found throughout the unit, with massive and platy soil structures observed in recent burn scars; these characteristics result in a a fair rating for soil structure and macro-porosity for unit 05. Observed erosion in units 03 and 04 is low, however, high compaction rates and wide variability in soil structure is found throughout the units resulting in a poor soil structure and macro-porosity rating for both.

Soil structure and macro-porosity in the project area appears to have been greatly affected by recent wildfire and to a lesser extent, past ground disturbing activities. Based on survey results, it can be assumed that areas burned at higher severity during the 2018 Camp Fire (units 03, 04, and portions of 02 and 05) have a high occurrence of fire related compaction and will have the poorest soils structure and macro-porosity. Additionally, areas with erosive soil textures and higher road densities (unit 01), will be more affected by naturally high erosion rates. Overall, it can be assumed that soil structure and macro-porosity is fair – poor throughout most of the project area.

Proposed Project

Direct, Indirect, and Cumulative Effects

The proposed project will be implemented in 3 treatment phases across 3 distinct treatment areas. In each phase, the area of focus will be prepared by constructing fireline, creating fuel breaks and removing hazardous fuels. These activities will be carried out using a combination of mechanical and biological methods including livestock grazing, dozer or excavator piling, yarding, mastication and chipping. After site preparation, prescribed burning will be applied at regular intervals (every three-to-five-years) with ground ignitions and aerial ignitions depending on treatment prescription.

The use of heavy equipment to prepare treatment zones has the potential to directly impact soil health by increasing compaction and soil strength. The project area is currently in fair to poor condition for compaction depending on land use history and burn severity. To limit and mitigate the direct effect of increasing soil strength, a soil moisture Limiting Operating Period (LOP) will be in place limiting heavy equipment operation to dry soil conditions. When feasible, existing system routes, legacy roads, skid trails and landings should be prioritized for heavy equipment use over new road, new landing, or temporary road construction due to high rates of compaction throughout the project area. Unit 03 had the most detrimental compaction at 42 percent, therefore treatments that minimize ground disturbance such as livestock grazing and underburning should be prioritized in this unit and its surrounding area to limit further compaction caused by heavy equipment. In order to decrease soil compaction within the project area, subsoiling should be prioritized on units 03, 04, 05, and any other areas that show evidence of significant compaction. Applicable practices of BMP Road-6 (Road Storage and Decommissioning) should be prioritized on roads surrounding units 03, 04, 05, and on new and existing landings, roads, and skid trails to return the area to resource production. To minimize further compaction in the project area, all applicable practices of BMP Road-6 will be used to obliterate all temporary roads and return the area to resource production after the access is no longer needed.

General trends of vegetation manipulation and thinning treatments on forest floor are well established, but precise effects are difficult to predict. The 2011 HFQLG Soil Monitoring Report presents the effects of this measure for over 100 units treated across 3 National Forests, including units on the Plumas National Forest. According to the report, thinning unit's averaged 90 percent effective soil cover pre-treatment and 83 percent post-treatment (Young, 2012). Given the average effective soil cover across surveyed areas was 85 percent and majority rock cover over ¾ inches in diameter , vegetation manipulation activities are not likely reduce effective soil cover below 50 percent standard for soil stability set by the Plumas National Forest Land and Resource Management Plan (USDA Forest Service, 1988a); therefore it is unlikely that the proposed vegetation manipulation and hazardous fuels removal will have adverse effects on soil stability in the project area.

Certain ground disturbing activities including mechanical treatments, new and temporary road construction, and fireline construction may lead to an increased the risk of surface erosion in portions of the project area. To help reduce the risk of increased surface erosion and soil loss, skid roads and trails associated with vegetation manipulation should be constructed along slope contours. Similarly, when constructing permanent fireline, the same slope contour consideration should be applied when possible. In instances where it may be necessary to construct fireline parallel with hillslope, consider utilizing alternatives to traditional fireline such as system roads or rock outcrops. Where traditional fireline must be constructed parallel with hillslope, construct waterbars at appropriate intervals and proportions to diffuse surface runoff to mitigate surface erosion and topsoil displacement. If permanent fireline is constructed in Unit 01 or in other

locations with granitic soils, waterbar spacing should be reduced to create more frequent breaks in slope. This will allow surface runoff to be intercepted and directed away from the exposed control line surface, reducing surface erosion and soil displacement on highly erodible soils. After treatment, permanent fireline should be covered with hazardous fuels mastication, chips or straw to reduce the risk of erosion while not being utilized for prescribed fire control. This layer should be enough to sufficiently slow down surface flow, but minimal enough to be removed easily when necessary to re-open permanent firelines.

Prescribed burning has the potential to consume fine organic material during application, directly impacting surface organic matter within the project area. Due to the high severity burns that occurred on the landscape, much of the existing duff, leaf litter, humus, and tree canopy was consumed in units 03, 04, 05. In order to increase fine organic material in these units consider treating bare soils with hazardous fuels mastication, chips or straw to minimize surface erosion and maintain or increase desirable surface organic matter. It is also recommended that prescribed fire be conducted at low intensity with fuel moistures that will help maintain the 50 percent standard for surface organic matter throughout the project area.

Hand and machine pile burnings have the potential to decrease effective soil cover and fine organic matter. Soil and other non-combustible materials should be kept from piles, and piles should be constructed in a manner that promotes efficient burning to minimize the temperature and amount of time fire is on the soil underneath burning piles. Where possible, burn piles should be constructed on rock outcrops to eliminate soil exposure to burning. Overall, the impacts associated with pile burning will not be widespread and will be limited to pile locations.

Soil surveys indicate that effective soil cover on average is above 50 percent and that fine organic matter is largely fair-good in the project area. These two components are important to the soils ability to immobilizing, degrading or detoxifying chemical compounds or excess nutrients (i.e. top soil runoff). Currently no known pesticides use, or chemical spills are known within the project that would degrade water quality, therefore the ability of project area soils to filter and buffer chemical compounds or excess nutrients from degrading water quality remains good and will not be affected by project activities.

The 2011 Best Management Practices Evaluation Program (BMPEP) Report found the overall effectiveness of 93.8 percent of timber associated BMPs and 98 percent effectiveness of prescribed fire associated BMPs (USDA Forest Service, 2011b). When coupled with the implementation of BMPs and design features, the cumulative effects of the proposed actions are unlikely to significantly alter soil function in the project area. Despite this, national soil quality standards for Surface Organic Matter, Soil Strength, and Soil Hydrologic Function are not met in units 03, 04, and 05 under existing conditions. In order to minimize the likelihood of adverse effects on soil resources from the proposed activities, treatments that may increase compaction or decrease fine organic matter including mechanical treatments and prescribed burning should be

delayed in time or space until national soil quality standards can be met or exceeded in all treatment units.

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Appendix A: Concow Pyrodiversity Project Integrated Design Features

1. If a treatment unit does not to meet the project standard of 50 percent effective soil cover, treat bare soils with hazardous fuels mastication, chips, or straw where possible to increase effective soil cover.
2. Areas with evidence of past land sliding should be evaluated by a qualified specialist before and after treatment to ensure crew safety and to reduce the risk of landslide initiation as a result of project activities.
3. Burn piles may be ignited independent of an underburn but should be placed at least 25 ft. from the edge of stream banks, springs, and other riparian areas before ignition.
4. When feasible, existing system routes, legacy roads, skid trails and landings should be prioritized for heavy equipment use over new road, new landing, or temporary road construction.
5. Treatments that minimize ground disturbance such as livestock grazing and underburning should be prioritized in units that burned at high severity during the 2018 Camp Fire or where soil compaction is common (units 03, 04, 05).
6. Subsoiling should be prioritized on units 03, 04, 05, and any other areas that show evidence of significant compaction.
7. Obliterate all temporary roads and return the area to resource production after the access is no longer needed.
8. Where possible construct skid roads, skid trails, and fireline along slope contours. Where roads and fireline must be constructed parallel with hillslope, construct waterbars at appropriate intervals and proportions to diffuse surface runoff to mitigate surface erosion and topsoil displacement.
9. Where possible consider utilizing alternatives to traditional fireline such as system roads or rock outcrops in order to minimize soil disturbance
10. After treatment, permanent fireline should be covered with hazardous fuels mastication, chips or straw to reduce the risk of erosion while not being utilized for prescribed fire control.
11. In units with less than 50% fine organic material, treat bare soils with hazardous fuels mastication, chips, or straw where possible.
12. Conduct prescribed burning operations at low intensity with optimal fuel moistures that will help maintain the 50 percent standard for surface organic matter throughout the project area.
13. Evaluate treatment areas before and after treatment to identify sites that may need stabilization including areas with evidence of landsliding and mass wasting.
14. When performing pile burning operations, soil and other non-combustible materials should be kept from piles.

15. Burn piles should be constructed in a manner that promotes efficient burning to minimize the temperature and amount of time fire is on the. Where possible, construct burn piles should on rock outcrops to eliminate soil exposure to burning.

16. Delay prescribed in time or space until national soil quality standards can be met or exceeded in all treatment units.

Analysis of Riparian Conservation Objectives

Riparian Conservation Objectives (RCOs) are presented and described in Appendix A of the 2004 ROD for the Sierra Nevada Forest Plan Amendment (USDA 2004). Integral to achievement of these objectives are the 32 prescribed standards and guidelines for riparian conservation areas listed in section D of the ROD. These standards and guides provide requirements for stream crossing structures, coarse woody debris in treated areas, identification of restoration needs, and many other Forest management activities that are not usually applicable to PNF vegetation management or road / motorized trail treatments. An analysis of the RCOs relative to PNF vegetation management or road / motorized trail treatments is presented below.

RCO #1: Ensure that identified beneficial uses for the water body are adequately protected. Identify the specific beneficial uses for the project area, water quality goals from the Regional Basin Plan, and the manner in which the standards and guidelines will protect the beneficial uses.

Existing beneficial uses for PNF surface waters are identified in the Central Valley Water Quality Control Plan for the Sacramento and San Joaquin River Basins (CVRWQCB, 1998). This plan identifies beneficial uses for specific water bodies and states that those beneficial uses generally apply to tributary systems of those water bodies. Project area streams flow into the North Fork of the Feather River and Lake Oroville. The beneficial uses are identified in the table below.

Beneficial Use	Lake Oroville	North Fork Feather River
Municipal and domestic water supply include the uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.	X	X
Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing.	X	
Hydropower generation includes the uses of water for hydropower generation.	X	X
Water Contact Recreation (REC-1) - Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.	X	X
Non-contact Water Recreation (REC-2) - Uses of water for recreational activities involving proximity to water, but where there is generally no body contact with water, nor any likelihood of ingestion of water. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.	X	X
Warm Freshwater Habitat (WARM) - Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.	X	
Cold Freshwater Habitat (COLD) - Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.	X	X
Migration of Aquatic Organisms (MIGR) – Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms,		

such as anadromous fish.		
Spawning, Reproduction, and/or Early Development (SPWN) - Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.	X	X
Wildlife Habitat (WILD) - Uses of water that support terrestrial or wetland ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.	X	X

Among these beneficial uses, aquatic habitat is the most sensitive to delivery of fine sediment that could potentially result from land disturbing activities. Effective implementation of US Forest Service BMPs (USDA, 2012) and design elements (Appendix A), which including streamside protection zones, soil stabilization treatments, and road drainage implementation measures would prevent sediment delivery and other contaminants from entering streams that would significantly affect the beneficial uses of water resources in and downstream of the project area.

RCO #2: Maintain or restore: (1) the geomorphic and biological characteristics of special aquatic features, including lakes, meadows, bogs, fens, wetlands, vernal pools, springs; (2) streams, including in stream flows; and (3) hydrologic connectivity both within and between watersheds to provide for the habitat needs of aquatic-dependent species.

PNF vegetation management and road / motorized trail treatments contain several elements directly aimed at improving water quality in the project area. National Forest System road improvements at stream crossings and removal or crossings on obliterated non-system roads will improve water quality and stream flow in the project area. The removal of vegetation in the project areas may also increase local soil moisture and increase stream flows.

Project design features, including equipment exclusion zones and standard BMPs implemented during forest thinning, prescribed grazing, and prescribed fire activities would prevent sediment delivery to special aquatic features that would significantly affect water and habitat quality.

RCO #3: Ensure a renewable supply of large down logs that: (1) can reach the stream channel and (2) provide suitable habitat within and adjacent to the RCA.

In most forested landscapes, large woody debris (LWD) is an essential element of proper functioning channel condition. LWD provides aquatic and terrestrial habitat diversity, structural conditions within channels (e.g., pool formation and fine sediment retention) and may increase channel shading thus reducing water temperatures.

For PNF mechanical thinning treatments, equipment exclusion zones along streams and special aquatic features will limit the taking of the larger trees in those areas and will ensure a supply of down logs to the RCAs. Also, the 30-inch upper diameter limit throughout the project area will allow for the recruitment of larger trees on the landscape.

RCO #4: Ensure that management activities, including fuels reduction actions, within RCAs and Critical Aquatic Refuges enhance or maintain physical and biological characteristics associated with aquatic- and riparian-dependent species.

Project specific design elements are included in project-level NEPA analyses for PNF projects that include Critical Aquatic Refuges, such as the 115,939-acre Critical Habitat Unit for California Red-Legged Frog that exists in in Butte and Plumas counties. The Plumas and Lassen national forests manage about 81 percent of this unit. The physical and biological characteristics associated with aquatic- and riparian-dependent species would be maintained for PNF vegetation management and road / motorized trail treatments through implementation of BMPs and typical design features.

RCO #5: Preserve, restore, or enhance special aquatic features, such as meadows, lakes, ponds, bogs, fens, and wetlands, to provide the ecological conditions and processes needed to recover or enhance the viability of species that rely on these areas.

As described under RCO #2, PNF vegetation management and road / motorized trail treatments are designed to improve the condition and sustainability of streams and wetlands within the project area. Equipment exclusion zones for special aquatic features are designed to protect project soil measures and water quality.

RCO #6: Identify and implement restoration actions to maintain, restore or enhance water quality and maintain, restore, or enhance habitat for riparian and aquatic species.

In addition to aspen and meadow restoration treatments described above, system road improvements and non-system road obliterations will directly improve water quality and habitat for aquatic and riparian species. Additionally, the reduction of excessive forest fuels will decrease the risk of high severity wildfire which has been shown to put water quality and habitat at risk.